A HEADPOINTING TECHNIQUE FOR USE WITH STANDARD COMPUTER SYSTEMS: THE LONG-RANGE OPTICAL HEADPOINTER

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ABSTRACT

A Long Range Optical Pointer (LROP) provides direct selection headpointing capability to standard commercially available computers. The LROP can be used from distances of up to three feet. The computer uses the continous position information generated by the LROP to provide continuous feedback to the user on the position being pointed to. Although the LROP is not in itself a communication or control system, a major application of the LROP is in dual computer systems, where one computer is used as an optimized input interface to a second, unmodified, computer running standard applications software and peripherals.

INTRODUCTION

Headpointing is a popular technique for disabled individuals who have lost functional use of their extremities, but who have residual head control. These characteristics are found in persons with high level spinal cord injuries or cerbral palsy, or amputees, among others. Several devices of varying degrees of complexity and success have been developed to enable a person to communicate using the headpointing technique.

The simplest type of headpointing involves the use of a headstick; this consists of a rod mounted to the user's head via a helmet or brace of some type. By moving his/her head, the user can point with the end of the rod at characters on a pointing board or activate the keys on the keyboard of a typewriter or computer. The device is very simple and easy to implement, but problems develop when it is used to control keyboards. These problems include:

1) Keyboards often require multiple simultaneous key closures for shift and control characters.

2) Users may have trouble selecting the desired key without inadvertently touching other keys.

3) Headsticks are often awkward, and can easily knock over objects near the user.

The first two problems have been alleviated with the use of custom key locks and keyguards. Even with these modifications, however, the top typing rate achievable only approaches the typing rate of a one-fingered

typist, which is unacceptable in most vocational and educational situations.

More complex headpointing devices were developed with the use of photocells and LED arrays (Prentke Romich Company, 1982). In these devices, the LEDs are laid in a row/column matrix, with specific characters, words or phrases associated with each LED. The LEDs are "flicker-lit" until a selection is made; each one turns on and then off again very quickly, in sequence. The rate of flicker is fast enough that it is invisible to the user. The photocell is mounted to the user's head, again via a helmet or brace. To make a selection, the user points the photocell at an LED for a specified period of time. The photocell detects the very quick turn-on of that particular LED, and relays the information back to the microprocessor. The only feedback provided to the user, however, is that the single LED being pointed to stays lit, rather than just flickering. This provides problems for some users when they drift away from the center of the target (the LED) toward an adjacent target, but are unaware of doing so because of the discrete, on-target/not-on-target feedback. This problem is somewhat corrected with the use of a hybrid pointer, which shines a light on the area being detected. With this, the user can see if he/she is drifting away from the LED, but there are problems both with additional expense and with alignment between the photocell and the light beam.

Additional enhancements over the basic pointing board include the addition of printers for hard copy and single-line displays for automatically accumulating messages. Other enhancements are line editing capabilities and the use of abbreviation expansion for increasing communication rates. Even with these enhancements, however, most systems do not meet the writing and conversation requirements needed in educational/vocational situations.

There is also a very high cost/function ratio inherent with customized displays and computer hardware and software in low volume products. Problems also occur in the maintenance and repair of custom devices because of the lack of local service, forcing the equipment to be sent back to the manufacturer for repair and depriving the user of the aid for long periods of time. The system is virtually impossible to upgrade because of the custom nature of the design.

LONG RANGE OPTICAL POINTER

The Long Range Optical Pointer (LROP) was designed to provide continuous headpointing position information and to be compatible with standard commercially available computers (Figure 1). The LROP is used in conjunction with a standard video monitor, with the video display controlled by the computer. The LROP pointer consists of two parts (Figure 2). The first is a small transducer which is mounted to the user's head and is used to point to the video monitor, from distances of up to 3 feet. The second part is a box which translates detections from the transducer into the coordinates on the screen being detected. The coordinates are sent to the computer via a standard RS-232 serial port. The computer can then draw a cursor on the screen at the coordinates to provide continuous position feedback to the user of where he/she is pointing.

There are many advantages to such a system, most of them due to the standard nature of the computer and video monitor. Commercial computers have a much lower cost/function ratio than custom computers developed specifically for handicapped populations. The service and maintenance on commercial computers is also much easier to obtain through local dealers. The system is easily upgradable for more powerful functions because commercial computers are more general purpose in design and have much better software developement tools. Programs can be written in the higher level and more powerful languages that are available for commercial computers. The display is also not fixed, as it is with LED arrays. The video monitor can present an infinite number of display configurations to meet the specific needs of each user. Also, high resolution graphics allow a variety of cursors to give the user feedback on the position being pointed to. Position averaging and prediction algorithms are also possible, to allow spastic individuals to increase selection rates. The only part of the system which is custom is the LROP, which is only a small part of the total system cost.

APPLICATION

The LROP is initially being designed to be used in a stationary, dual computer system (Vanderheiden, 1981). Dual computer systems provide transparent access to standard computers and software for persons who have difficulty using normal keyboards. A dual computer system in this case consists of two standard commercially available computers; the first provides the handicapped individual with a specialized and optimized input interface, and the second provides him/her with the standard application software required in vocational/educational situations. The first computer sends the user's selections to the second computer through a hardware interface that makes the second computer think that the selections came from its own standard keyboard. This provides transparent access to any software on the second computer. Two computers are required because these two functions cannot be implemented on the same computer without severely compromising the sophistication and the utility of the input and application programs. This does not mean the two computers need to be the same type of computer. Selection of each computer will depend on the interface and application functions required. The LROP will allow the first computer to incorporate direct selection headpointing with a minimal amount of external custom hardware. A typical dual computer system using the LROP would consist of:

Computer 1	Computer 2
Standard Computer	Standard Computer
Input Technique Software	Standard Software
LROP	Keyboard Emulator

The first client to use the LROP in a dual computer configuration is using an Apple IIe as his "input" computer, and will be interfacing to a DEC VT 100 terminal through a keyboard emulator (Fig. 3). The input software includes a high resolution graphics display on a video monitor of a standard keyboard (Figure 1), a ten-branch abbreviation expansion algorithm,

and a programmable dictionary. Selections from the "keyboard" are made by pointing the LROP at the keys drawn on the monitor. The time that the LROP must be pointed toward the desired "key" in order to activate it is user-programmable.

CONCLUSION

The LROP is not a communication or control aid in itself, but was designed to be used as the input transducer of standard computer systems being used as communication aids. The use of standard computer systems will help provide lower cost and more powerful communication devices for the handicapped. The stand-alone LROP can then be easily interfaced with any commercial computer, including the new portable computers. This allows the LROP to grow with the user as his/her computer needs change and more powerful software and computers become available.

REFERENCES

Prentke Romich Company, 1982. Catalog of electronic aids., Shreve, OH.

Vanderheiden, G.C. 1981. Practical applications of microcomputers to aid the handicapped. IEEE Computer 14:1 pp. 54-61.

Figure captions

Figure 1 Long Range Optical Pointer being used with high-resolution graphics keyboard and ten-branch abbreviation program.

Figure 2 Long Range Optical Pointer head-mounted transducer and position resolver module. Connectors appearing on the front of the module are for video signal and serial communication.

Figure 3 The dual computer system using the LROP includes Apple IIe computer, disk drive, serial interface card, and input technique software. The second computer is accessed through a keyboard emulator and a DEC VT 100 terminal.

LROP
Transducer

LROP
Module

Serial Data | Serial Data | Serial Data

Video Monitor

Apple IIe

Disk

Keyboard
Emulator

DEC VT 100 Terminal

Standard Keyboard

Mainframe
Computer

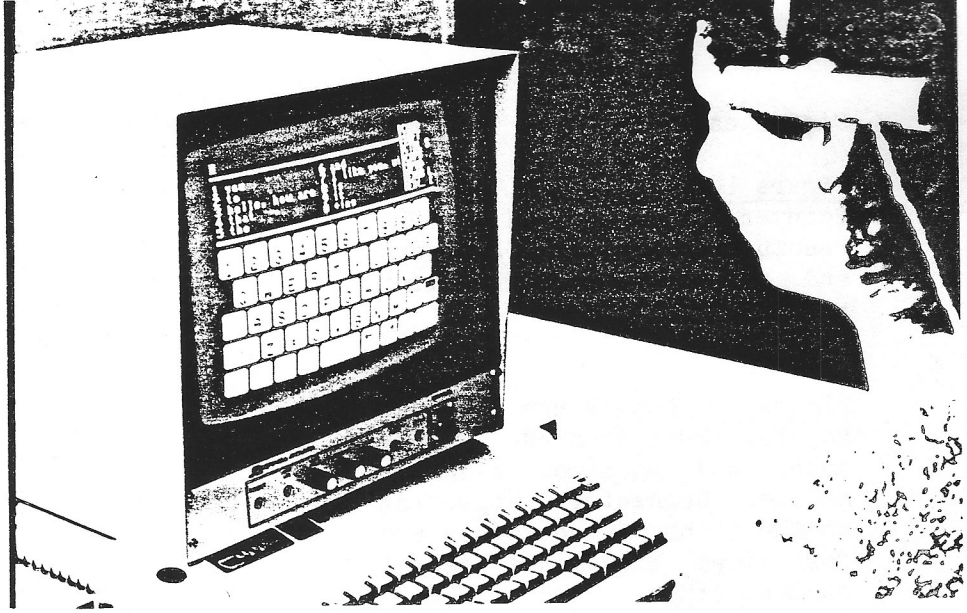

Fig. 1 Long Range Optical Pointer being used with high-resolution graphics keyboard and ten-branch abbreviation program.

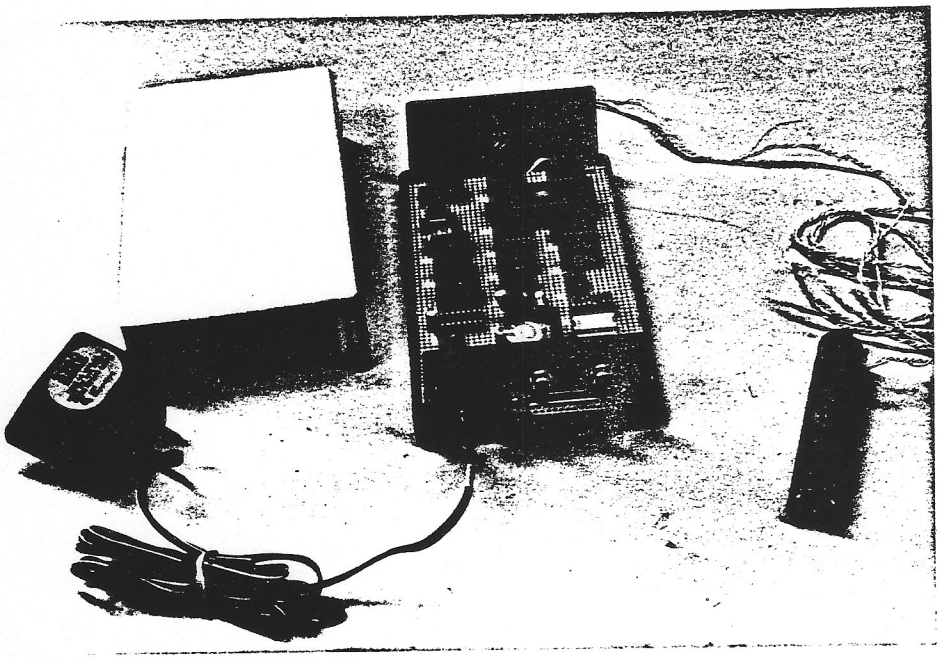

Fig. 2 Long Range Optical Pointer head mounted transducer and position resolver module. Connectors appearing on the front of the module are for power, the video signal and serial communication.

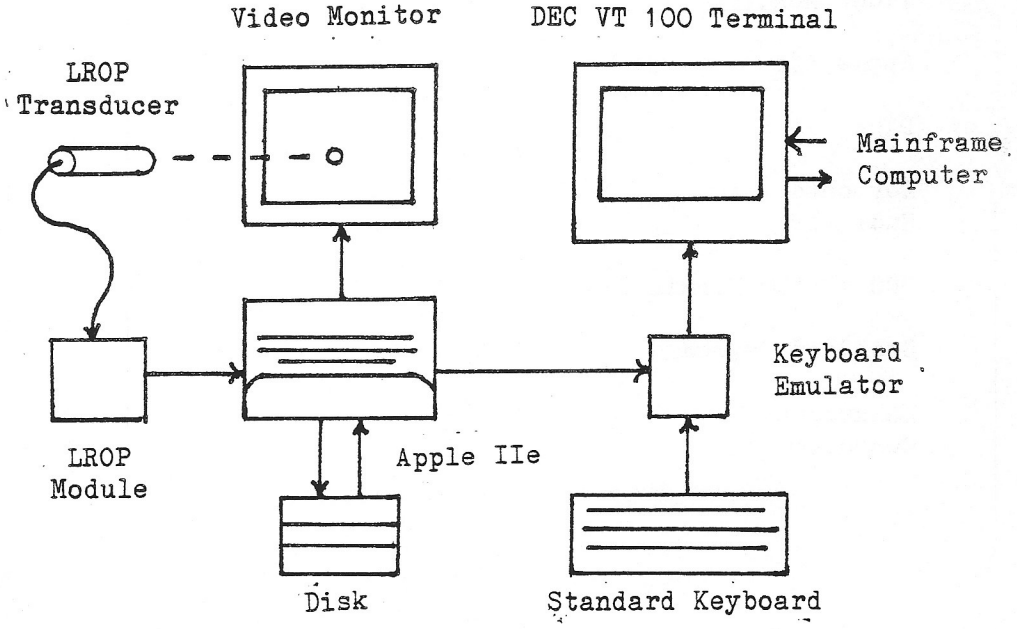

Fig. 3 A dual computer system using LROP includes Apple IIe computer, disk drive, serial interface card, and input technique software. The mainframe computer is accessed through a keyboard emulator and a DEC VT 100 terminal.